

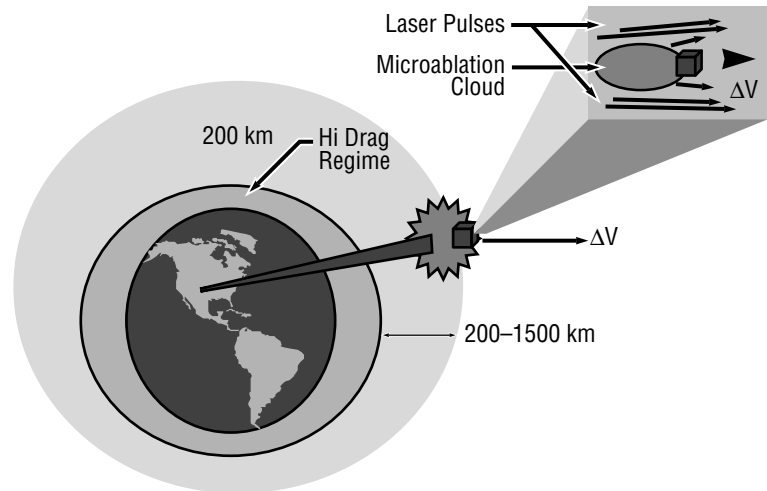
## Beamed Energy Research Program for Propulsion and Planetary Defense

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Beamed energy may be accomplished at many different wavelengths including microwave, infrared, and the visible portions of the electromagnetic spectrum. Lasers are used in the infrared and visible regimes because of their low divergence over transmission ranges.

Laser technology is maturing rapidly. Atmospheric propagation problems such as thermal blooming and stimulated Raman scattering have been overcome by building lasers that operate at short pulse widths. New programs are on the horizon for using lasers in defensive roles. These include antimissile defenses on sea, air, and space-based platforms. Lasers may also be used to “push” orbital debris into the atmosphere for elimination as a space hazard (fig. 88). Developing laser systems to deal with the orbital debris problem would be a stepping stone to larger systems based on the laser/momentum transfer principle. These larger systems could potentially be used to deflect inbound asteroids and comets.

In addition to engaging noncooperative targets, lasers may also be used in a cooperative sense to propel specially configured launch vehicles both in the atmosphere and in space.



**FIGURE 88.—Project ORION: Orbital debris removal using ground-based sensors and lasers.**

During this past year we have made substantive progress on several technological fronts. In the area of orbital debris removal, we have demonstrated using a torsional pendulum suspended in vacuum that we can impart significant momentum to a target with a laser pulse. In fact, the preliminary outcome of these experiments has been to show that the effect is more pronounced than we thought. The implications of this finding if verified are that less intensity would be required on the target particle, hence adding technological margin to the mission concept. In other words, should the laser beam be degraded in transit to orbit, there should still be sufficient intensity to slow the particle down. This was a major breakthrough in developing this technology.

In addition, at White Sands we have achieved a major breakthrough in the application of using lasers to propel cooperative targets. In highly significant proof-of-principle joint United

States Air Force/NASA tests, we have demonstrated that we can leave the propulsion system on the ground and use the ambient air as a working medium to launch a payload (fig. 89). This opens a promising new chapter in propulsion technology.



**FIGURE 89.—Night launch of a light craft capsule using a ground-based laser.**

**Biographical Sketch:** Dr. Jonathan W. Campbell holds a Ph.D. in astrophysics and space science from the University of Alabama. In addition, he holds three master's degrees and a bachelor's in aerospace engineering from Auburn. He is a Colonel in the Air Force Reserve assigned to Air University and is an active Certified Instrument Instructor. During his career, he has worked for NASA, the Army Missiles and Space Intelligence Agency, the National Air Intelligence Agency, and Pratt and Whitney Aircraft. Currently, his primary research interests are in the areas of planetary defense, including orbital debris removal, gravitational breakthrough physics, and astrophysics. He has authored over 50 publications.

**Sponsor:** Advanced Space Transportation Programs Office

**Other Involvement:** United States Air Force ►